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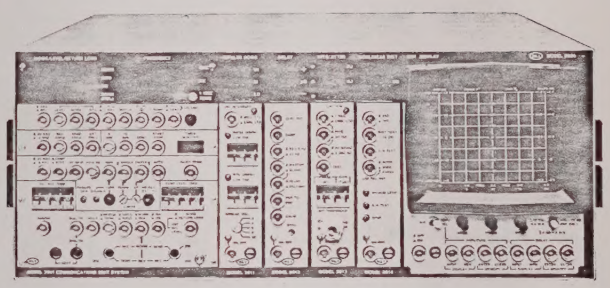
OPERATING MANUAL
MODEL 3901
COMMUNICATIONS TEST SYSTEM
BASIC UNIT



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MODEL 3901 COMMUNICATIONS TEST SYSTEM BASIC UNIT

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1. GENERAL

1.01 This manual contains information needed for installation and operation of the HLI Model 3901 COMMUNICATIONS TEST SYSTEM Basic Unit. This section covers the functional description and specifications of the Basic Unit. Figure 1 shows the Model 3901 COMMUNICATIONS TEST SYSTEM with selected plug-in modules installed.

DANGER: Hazardous voltages exist inside this instrument.

A. Functional Description

1.02 The Model 3901 Basic Unit provides the following line interface arrangements.

- 4-wire/2-wire
- Handset/headset compatible
- Dual hold

1.03 The Basic Unit measure the following transmission parameters of communications channels, up to 20 kHz:

- Level
- Noise (voiceband filter weighted)
- Noise-to-ground (voiceband filter weighted)
- Sine wave return loss
- Frequency

1.04 The Basic Unit has a signal generator which can be set to function in the following modes:

- 1004 Hz holding tone
- Manually tuned oscillator
- Automatic sweep oscillator

The generator output level can be varied by using front panel thumbwheel switches.

1.05 The Basic Unit has a built-in, self-test capability for performing the following checks:

- Level/noise
- Frequency counter
- Signal generator
- Filter response

B. Specifications

1.06 Specifications for the Model 3901 Basic Unit are contained in Table A.

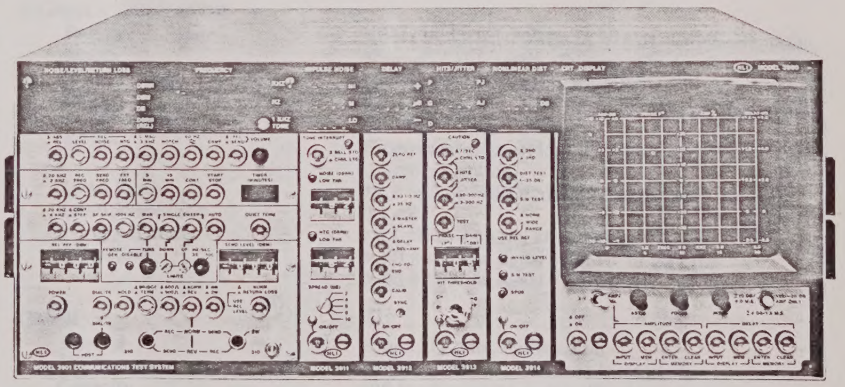

Figure 1. Model 3901 COMMUNICATIONS TEST SYSTEM (with Selected Plug-In Modules Installed)

TABLE A. MODEL 3901 SPECIFICATIONS*

LEVEL MEASUREMENT	
Frequency Range	40 Hz to 20 kHz
Level Range	+10.0 to −80.0 dBm
Relative Adjustment Range	+9.9 to −39.9 dBm
Accuracy	±0.1 dB at 1000 Hz from 0 to −19 dBm ±0.2 dB from +10.0 to −50 dBm, 200 Hz to 15 kHz ±0.5 dB from +10.0 to −50 dBm, 40 Hz to 20 kHz
NOISE MEASUREMENT	
Weighting Filters	C Message; 3 kHz Flat; Holding Tone Notch
Measurement Range	+10 to +100 dBrn (noise) +40 to +130 dBrn (noise-to-ground)
	±1.0 dB (noise) ±1.5 dB (noise-to-ground)
FREQUENCY MEASUREMENT	
Measurement Range	40 to 19,999 Hz (20 kHz range) 40.0 to 1,999.9 Hz (2 kHz range)
Resolution	1 Hz (20 kHz range) 0.1 Hz (2 kHz range)
Accuracy	±1 Hz (20 kHz range) ±0.1 Hz (2 kHz range)
Update	10/second (20 kHz range) 1/second (2 kHz range)
SINE WAVE RETURN LOSS	
Measurement Range	0.0 to +50.0 dB (2-wire) −9.9 to +50.0 dB (4-wire)
Accuracy	±0.5 dB (4-wire)
Standard Impedance (2-wire)	600 Ω, 900 Ω ±1% in series with 2.16 μF ±1%, or external standard
SIGNAL GENERATOR	
Frequency Range	40 Hz to 4 kHz, 200 Hz to 20 kHz, switch selectable
Modes	Manual, Automatic Sweep, Single Sweep Up, Single Sweep Down, 1004 Hz
Control	Continuous and 100 Hz lock with +4 Hz offset
Sweep Limits	Front panel adjustable
SF Skip	Frequency skip and/or Mute (factory set at customer's option)
Level Range	+9.9 to −39.9 dBm, quiet termination
Level Resolution	0.1 dB
Level Accuracy	±0.1 dB to 15 kHz, ±0.2 dB to 20 kHz
Distortion	> 50 dB below signal (100 Hz to 20 kHz) > 60 dB below signal (1004 Hz)
TIMER	
Interval	5 min., 15 min., continuous
Display	Elapsed time in 0.1 minute increments
Capacity	999.9 minutes (16 hours, 40 minutes)

TABLE A. MODEL 3901 SPECIFICATIONS (Cont.)

GENERAL	
Terminated Impedance	600 Ω, 900 Ω, with 200 V dc block
Bridging Impedance	Causes less than 0.2 dB bridging loss error
Balance	> 80 dB at 60 Hz
Return Loss	> 30 dB
Hold/Dial/Talk	Full 2-wire/4-wire capability (Two 2-wire holding circuits are provided)
Monitor Speaker	Rear panel. Front panel volume control (approx. 250 mW)
EXTERNAL OUTPUTS	
DC	Proportional to Frequency Proportional to dB Level Proportional to Group Delay
AC	Monitor Output Phase Jitter Waveform Amplitude Jitter Waveform Receive and Send Binding Post Connections
POWER	105-130/210-260 Vac (switch selectable) 47-63 Hz, 20 to 80 watts depending on modules selected
SIZE	
3900L (8 Plug-ins)	17.25 in. (43.8 cm.) W x 7 in. (17.8 cm.) H x 17.85 in. (45.3 cm.) D
3900S (4 Plug-ins)	11.85 in.(30.1 cm.) W x 7 in. (17.8 cm.) H x 19.35 in. (49.2 cm.) D
WEIGHT	25-40 lbs. (11.3-18.1 kg.) depending on installed modules.

* All stated and unstated specifications are intended to comply with Bell System standards as contained in Bell System Technical Reference PUB 41009 dated May 1975

HLI reserves the right to make changes in specifications at any time without notice.

2. AC POWER CONSIDERATIONS

2.01 This section contains information pertaining to the ac power connection and power sources compatible with the Model 3901 Basic Unit.

2.02 The Basic Unit may be operated from a source of 105 V ac to 130 V ac, or 210 V ac to 260 V ac at line frequencies from 47 Hz to 63 Hz.

WARNING: Failure to set the 115/230 volt selector switch to the proper setting before connecting the power cord to the power source may damage the unit.

With the power cord disconnected, move the 115/230 volt selector switch (located on the rear panel as shown in Figure 2) until the desired voltage indication of 115 or 230 is visible. A narrow-blade screwdriver may be used to operate the switch. The fuse should be a 1 ampere slow-blow for 115 volt operation or a 0.5 ampere slow-blow for 230 volt operation.

2.03 The Basic Unit is supplied with a detachable three-conductor power cable (Belden PN KH-8828) which, when plugged into an appropriate receptacle, grounds the chassis to the power line ground. To retain this protective feature when the power cable is plugged into a two-wire outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to an appropriate ground.

2.04 If for any reason the chassis cannot be grounded through the power cable, it is recommended that the Basic Unit be grounded via the front panel (refer to Figure 3) ground post, by the GND terminals on the rear panel barrier strip, or any of the three black, five-way binding posts located on the rear panel.

2.05 When the unit is received, it is recommended that the self-test procedure in Section 15 be performed to determine that the unit is electrically operational.

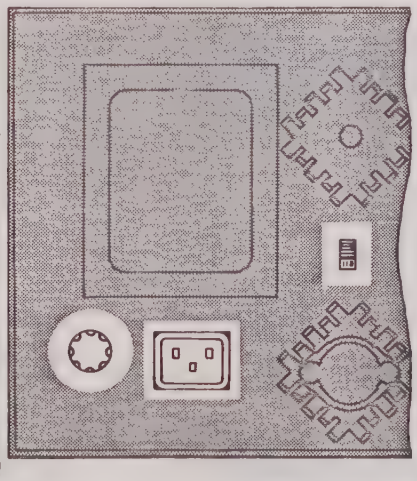

Figure 2. Rear Panel AC Power Receptacle, 115/230 Volt Selector Switch, and Fuse

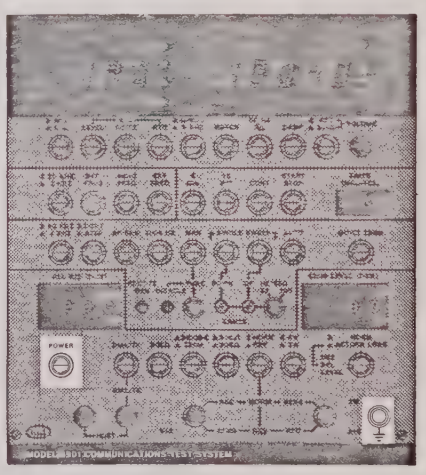

Figure 3. Front Panel AC Power Switch and Ground Post

3. CONTROLS, INDICATORS AND JACKS

3.01 This section contains descriptions of all controls, indicators and jacks on the Model 3901 Basic Unit. See Figure 4.

(1) DIAL/TK, HDST Jacks

Provides connection for a lineman's handset or a headset.

(2) POWER Switch

Switches Basic Unit power on and off.

(3) Thumbwheel Switches

REL REF (DBM) – Sets reference level from +9.9 to –39.9 dBm for relative measurement.

SEND LEVEL (DBM) – Sets send level from +9.9 to –39.9 dBm.

(4) Generator Mode Controls and Indicator

20 KHZ/4 KHZ – Sets generator range to either 20 kHz or 4 kHz.

CONT/STEP – Selects continuous frequency adjustment or discrete adjustment in 100 Hz steps.

SF SKIP – Sets the generator to skip from 2450 to 2750 Hz. It can be made to mute and/or skip at customer's option.

REMOTE GEN – Indicates when basic unit generator is not supplying the send signal.

(5) Frequency Counter Controls

20 KHZ/2 KHZ – Sets counter range. In 20 kHz range, counter updates 10/sec with 1 Hz resolution. In 2 kHz range, counter updates 1/sec with 0.1 Hz resolution.

REC FREQ – Selects receive frequency for display.

SEND FREQ – Selects send frequency for display. Send frequency can be displayed even in QUIET TERM mode.

EXT FREQ – Selects external frequency (applied via 5-way binding posts on the rear panel) for display.

(6) LEVEL/NOISE/NTG Controls

ABS/REL – Allows level readout to be either absolute or relative to the setting of REL REF (DBM) thumbwheels.

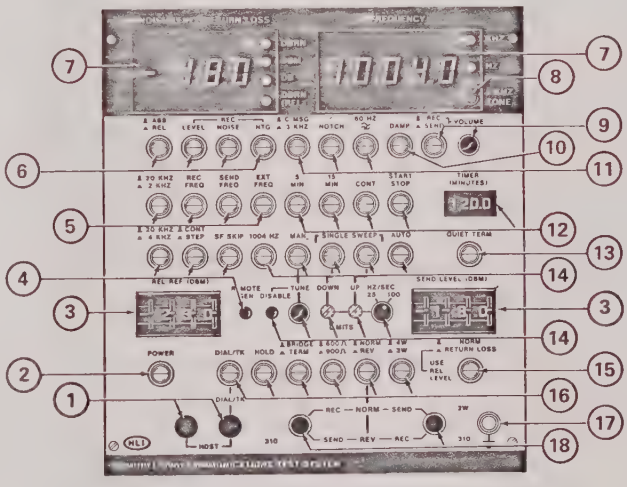

Figure 4. Controls, Indicators and Jacks

REC-LEVEL – Allows signal to bypass all noise weighting filters with the exception of 60 Hz ≈ filter.

REC-NOISE – Allows measurement of metallic noise (circuit noise) which has been weighted through noise weighting filters.

REC-NTG – Allows measurement of longitudinal noise (noise-to-ground) which has been weighted through noise weighting filters.

(7) LED Displays

LED readouts provide simultaneous information for level and frequency. Overrange is indicated with + sign while – sign indicates underrange. Appropriate units of measurement are given by LED indicators.

(8) 1 KHZ TONE Indicator

On when valid holding tone is received. Flashes when level is valid but frequency is from 980 to 990 Hz or from 1030 to 1040 Hz.

(9) Audio Controls

REC/SEND – Selects either receive or send signal for audio monitoring. Also feeds MON pin on the rear panel barrier strip.

VOLUME – Adjusts level of audio.

(10) DAMP Switch

Damps fluctuating reading.

(11) Filter Controls

C-MSG/3 KHZ – Provides selected weighting filter for noise measurement.

NOTCH – Notches out holding tone by more than 50 dB from 995 to 1025 Hz.

60 HZ ≈ – Reduces effect of power line interference on the reading. Can be used in all measurement modes.

(12) Timer Controls and Display

5 MIN – Sets timer interval to 5 minutes.

15 MIN – Sets timer interval to 15 minutes.

CONT – Timer runs until stopped by START/STOP switch.

START/STOP – Starts and stops timer.

TIMER (MINUTES) – Displays elapsed time with 0.1 minute resolution.

(13) QUIET TERM Switch

Provides a quiet termination on send line.

(14) Generator Frequency Controls and Indicator

1004 HZ – Selects 1004 Hz test tone with better than 60 dB purity.

MAN – Allows frequency to be manually tuned.

TUNE – Knob for manual tuning of frequency.

TUNE-DISABLE – Indicates when the basic unit tuning controls are disabled.

SINGLE SWEEP DOWN – Single sweeps the generator to the down limit.

SINGLE SWEEP UP – Single sweeps the generator to the up limit.

UP, DOWN LIMITS – Sets up and down sweep limits.

AUTO – Automatically sweeps generator between up and down limits.

HZ/SEC – Adjusts sweep rate.

(15) NORM/RETURN LOSS Switch

Selects normal or return loss measurement.

(16) Line Interface Controls

DIAL/TK – Used to dial and talk. When DIAL/TK is in, send function is disabled.

HOLD – Dual electronic hold circuit; holds 2-wire lines.

BRIDGE/TERM – Provides termination of both receive and send lines or bridges across receive lines.

600 Ω/900 Ω – Select to match line impedance.

NORM/REV – When set to NORM, the 310 jack on the right is the send jack and the 310 jack on the left is the receive jack. When set to REV, the jack functions are reversed.

4W/2W – Sets up Dial/Talk and Return Loss circuitry for 4-wire or 2-wire operation.

(17) Ground Post

The Basic Unit chassis is normally grounded through the power line. Where three-conductor power line is not available, the chassis should be grounded via this post.

(18) REC, SEND Jacks

The type 310 jacks provide interface between the test set and lines.

4. LINE INTERFACES

4.01 This section describes the line interface connections required to perform the various measurements described in subsequent sections.

4.02 The Model 3901 Basic Unit has two sets of balanced terminals and is capable of sending and receiving signals simultaneously. It is recommended that Western Electric 310 plugs or equivalent be used for line interface connections. Other types of audio plugs will deform the contacts and cause unsatisfactory performance of the 310 jacks. Refer to Figure 5 while performing the following line interface procedures.

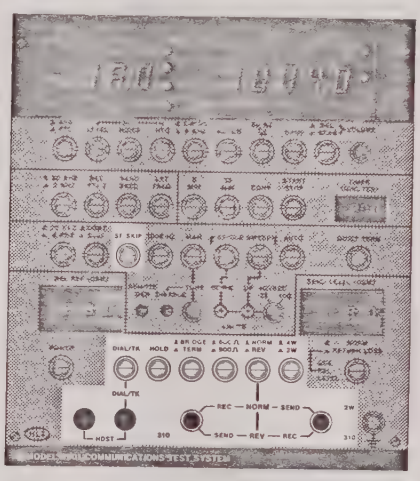

Figure 5. Line Interface Controls and Connectors

A. Impedance

4.03 The Basic Unit provides the two commonly used terminating impedances of 600 Ω and 900 Ω. The desired impedance is selected by setting the 600 Ω/900 Ω switch to the desired position.

Note: Failure to select the proper impedance will cause errors in both send and receive levels.

4.04 The Basic Unit can be bridged across or used as the terminating impedance for the receive line, by setting the BRIDGE/TERM switch to the appropriate position.

Note: In bridge mode, the send and receive levels are referenced to the selected terminating impedance (600 Ω or 900 Ω) although the bridging impedance is in excess of 25 kΩ.

B. Normal/Reverse

4.05 The NORM/REV switch enables the function of the two SEND/REC jacks to be interchanged and may be used in 2-wire or 4-wire operation. When the NORM/REV switch is set to NORM, the 310 jack on the right functions as the SEND jack and the 310 jack on the left functions as the REC jack. Setting the switch to REV reverses the functions.

4.06 There are two sets of five-way binding posts located on the rear panel (Figure 15, Section 14) for use when the Basic Unit is rack mounted. The T, R, and S binding posts are connected in parallel with the Basic Unit front panel NORM-REC jack, and the 2W-T1, -R1 and -S1 binding posts are connected in parallel with the front panel NORM-SEND jack.

4.07 The EXT-T, -R, -S five-way binding posts on the rear panel may be connected to the line for the purpose of frequency measurement only. These binding posts bridge across the line with a bridging impedance in excess of 10 kΩ for frequencies higher than 1 kHz.

C. 2-Wire

4.08 To interface with 2-wire lines, proceed as follows:

1) Set DIAL/TK switch to out position.
2) If it is necessary to hold the line under test, set HOLD switch to in position.
3) Set BRIDGE/TERM switch to appropriate setting (see Paragraph 4.04).
4) Set 600 Ω/900 Ω switch to match line impedance.

5) Set NORM/REV switch to NORM to send.
6) Set NORM/REV switch to REV to receive.
7) Set 4W/2W switch to 2W.
8) Set NORM/RETURN LOSS switch to NORM.
9) If sending over a dial-up network employing 2600 Hz SF (single frequency) signaling, set SF SKIP switch to in position. Otherwise, the dialed connection may be lost during test.
10) Connect 2-wire line to 2W (NORM-SEND) jack.

4.09 Since the Basic Unit is equipped with electronic hold circuits for both SEND and REC jacks, the NORM-REC jack may be used for 2-wire interface. This allows the Basic Unit to be used in a double 2-wire mode as required when performing a delay measurement in either the Forward or Return Reference mode on 2-wire facilities.

D. 4-Wire

4.10 To interface with 4-wire lines, proceed as follows:
1) Set DIAL/TK switch to out position.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to appropriate setting (see Paragraph 4.04).
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to NORM.
6) Set 4W/2W switch to 4W.
7) Set NORM/RETURN LOSS switch to NORM.
8) Set SF SKIP switch to in position if SF signaling circuit is in the path.
9) Connect send line to NORM-SEND jack.
10) Connect receive line to NORM-REC jack.

E. Dial/Talk

4.11 The Basic Unit is equipped with a versatile Dial/Talk circuit that enables a lineman's handset (butt-in) or a headset to be used in either 2-wire or 4-wire operation.

4.12 To call on a single 2-wire wet line, proceed as follows:
1) If sending over a dial-up network employing 2600 Hz SF signaling, set SF SKIP switch to in position. Otherwise, the dialed connection may be lost during test.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to BRIDGE.
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to REV.
6) Set 4W/2W switch to 2W.
7) Connect the line to 2W (REV-REC) jack.
8) Connect lineman's handset to DIAL/TK jack.
9) Set DIAL/TK switch to in position.
10) Dial up using the handset.
11) After the dialed connection has been established, set HOLD switch to in position.
12) To return to normal testing mode, set DIAL/TK switch to out position.
13) Set NORM/REV switch to NORM to send.
14) Set NORM/REV switch to REV to receive.
15) If Basic Unit is to be used as termination for receive line, set BRIDGE/TERM switch to TERM.

4.13 To answer on a single 2-wire wet line, proceed as follows:
1) If sending over a dial-up network employing 2600 Hz SF signaling, set SF SKIP switch to in position. Otherwise, the dialed connection may be lost during test.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to BRIDGE.
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to REV.
6) Set 4W/2W switch to 2W.
7) Connect the line to 2W (REV-REC) jack.
8) Connect lineman's handset to the DIAL/TK jack. Put the handset to "on-hook".
9) Set DIAL/TK switch to in position.
10) Answer using the handset.

11) After the dialed connection has been established, set HOLD switch to in position.
12) To return to normal testing mode, set DIAL/TK switch to out position.
13) Set NORM/REV switch to NORM to send.
14) Set NORM/REV switch to REV to receive.
15) If Basic Unit is to be used as termination for receive line, set BRIDGE/TERM switch to TERM.

4.14 The handset may remain plugged into the DIAL/TK jack without affecting the measurement in process. If it is desired to return to talk mode while the measurement is in progress, set the DIAL/TK switch to in position and NORM/REV to REV.

4.15 To call on a double 2-wire wet line, proceed as follows:

1) If sending over a dial-up network employing 2600 Hz SF signaling, set SF SKIP switch to in position. Otherwise, the dialed connection may be lost during test.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to BRIDGE.
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to NORM.
6) Set 4W/2W switch to 2W.
7) Connect send line to NORM-SEND jack.
8) Connect receive line to NORM-REC jack.
9) Connect lineman's handset to the DIAL/TK jack.
10) Set DIAL/TK switch to in position. The handset is now connected to the NORM-REC line.
11) Dial using the handset.
12) After the dialed connection has been established, set HOLD switch to in position.
13) Set NORM/REV switch to REV. The handset is now connected to the REV-REC line.
14) Listen for a dial tone. If it is not present, put the handset to "on-hook" and then back to "off-hook" to obtain a dial tone.
15) Dial using the handset.
16) After the dialed connection has been established, set DIAL/TK switch to out position to return to normal testing mode.
17) Set NORM/REV switch to NORM position.
18) If the Basic Unit is to be used as termination for receive line, set BRIDGE/TERM switch to TERM.

4.16 To answer on a double 2-wire wet line, proceed as follows:

1) If sending over a dial-up network employing 2600 Hz SF signaling, set SF SKIP switch to in position. Otherwise, the dialed connection may be lost during test.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to BRIDGE.
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to REV.
6) Set 4W/2W switch to 2W.
7) Connect send line to NORM-SEND jack.
8) Connect receive line to NORM-REC jack.
9) Connect lineman's handset to the DIAL/TK jack. Put the handset to "on-hook".
10) Set the DIAL/TK switch to in position. The handset is now connected to REV-REC line.
11) Answer using the handset.
12) After the dialed connection has been established, set HOLD switch to in position.
13) Set NORM/REV switch to NORM. The handset is now connected to NORM-REC line. Return the handset to "on-hook".
14) Answer using the handset.
15) After the dialed connection has been established, set DIAL/TK switch to out position to return to normal testing mode.
16) If the Basic Unit is to be used as termination for receive line, set BRIDGE/TERM switch to TERM.

4.17 The handset may remain plugged into the DIAL/TK jack without affecting the measurement in progress. If it is desired to return to talk mode while the measurement is in progress, set DIAL/TK switch to in position and NORM/REV to REV.

4.18 To talk or listen on a 2-wire dry line, proceed as follows using either a lineman's handset or a headset.

1) Set SF SKIP switch to in position if SF signaling circuit is in the path.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to appropriate setting (see Paragraph 4.04).
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to NORM to talk.
6) Set NORM/REV switch to REV to listen.
7) Set 4W/2W switch to 4W.
8) Set NORM/RETURN LOSS switch to NORM.
9) Connect the line to 2W (NORM-SEND) jack.
10) Connect a lineman's handset to DIAL/TK jack or a headset to HDST jacks.
11) Set DIAL/TK switch to in position.
12) To return to normal testing mode, set DIAL/TK switch to out position.
13) Set NORM/REV switch to NORM to send.
14) Set NORM/REV switch to REV to receive.

4.19 On 2-wire dry line, talk is possible from send to receive only and NORM/REV switch should be used to coordinate talk and listen.

4.20 To talk on 4-wire dry lines, proceed as follows using either a lineman's handset or a headset.

1) Set SF SKIP switch to in position if SF signaling circuit is in the path.
2) Set HOLD switch to out position.
3) Set BRIDGE/TERM switch to appropriate setting (see Paragraph 4.04).
4) Set 600 Ω/900 Ω switch to match line impedance.
5) Set NORM/REV switch to NORM.
6) Set 4W/2W switch to 4W.
7) Set NORM/RETURN LOSS switch to NORM.
8) Connect send line to NORM-SEND jack.
9) Connect receive line to NORM-REC jack.
10) Connect a lineman's handset to DIAL/TK jack or a headset to HDST jacks.
11) Set DIAL/TK switch to in position.
12) To return to normal testing mode, set DIAL/TK switch to out position.

4.21 When DIAL/TK switch is set to out position on dry lines, the handset and the headset may be left plugged in to monitor receive signal without affecting measurement. When DIAL/TK switch is set to in position, the headset can be used to talk and listen, while the handset can be used to talk only. However, the handset can be used to monitor receive signal at any time by connecting it to the left HDST jack.

5. LEVEL MEASUREMENT

5.01 This section describes the operating procedures for the Model 3901 Basic Unit when performing the following:

- Absolute Level Measurement
- Relative Level Mcasurement

5.02 Overrange and underrange indications are provided to alert the operator when the level of the signal being measured exceeds the measurement capability of the Basic Unit.

5.03 Selection of 60 Hz filtering and damping during a level measurement is also discussed in this section. Refer to Figure 6 while performing the following procedures.

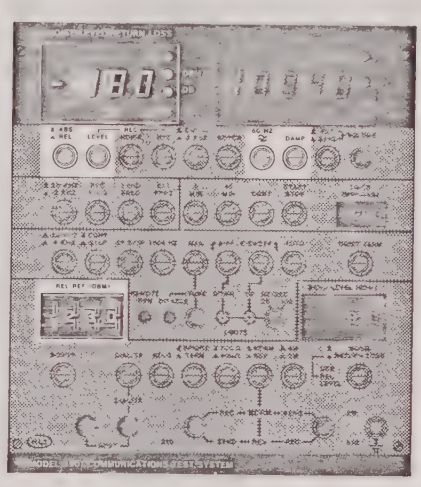

Figure 6. Level Measurement Controls and Displays

A. Absolute Level Measurement

5.04 To perform an absolute level measurement, proceed as follows:

1) Set ABS/REL switch to ABS.
2) Set REC-LEVEL switch to in position.
3) Refer to Section 4 for line interface information.
4) Read the absolute level directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DBM indicator to the right of the display.

B. Relative Level Measurement

5.05 To perform a relative level measurement, proceed as follows:

1) Set ABS/REL switch to REL.
2) Set REC-LEVEL switch to in position.
3) Set REL REF (DBM) thumbwheel switches to the desired reference level (e.g., TLP, Data Level, etc.).
4) Refer to Section 4 for line interface information.
5) Read the relative level directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DB indicator to the right of the display.

C. 60 Hz Filtering

5.06 The Basic Unit contains a 60 Hz high-pass filter that can be selected by setting the 60 HZ ≈ switch to in position. Selecting the filter will reduce the effects of power line interference on the level measurements.

D. Damping

5.07 If the reading fluctuates due to noise or low repetition rate of the signal, it can be damped by setting the DAMP switch to in position.

E. Overrange and Underrange Indications

5.08 If the received signal exceeds the measurement capabilities of the Basic Unit, one of the following overrange or underrange indications will occur:

- If the level goes above +10 dBm or +10 dB, the display will blank with the exception of the positive sign, indicating an overrange condition.
- If the level goes below −80.0 dBm or −80.0 dB, the display will blank with the exception of the negative sign, indicating an underrange condition.

6. NOISE MEASUREMENT

6.01 This section describes the operating procedures for the Model 3901 Basic Unit when performing the following:

- Absolute Noise Measurement
- Relative Noise Measurement
- Absolute Noise-to-Ground Measurement
- Relative Noise-to-Ground Measurement

This section also contains selection information for the following filters:

- C-Message
- 3 kHz Flat
- Notch
- 60 Hz High Pass

6.02 Damping may be selected for all noise measurements. Overrange and underrange indications are provided to alert the operator when the level of the signal being measured exceeds the measurement capabilities of the Basic Unit.

6.03 When making low-level noise or noise-to-ground measurements, it is recommended that the generator be put in the quiet termination mode by setting the QUIET TERM switch to in position. (Refer to Section 9.) Refer to Figure 7 while performing the following procedures.

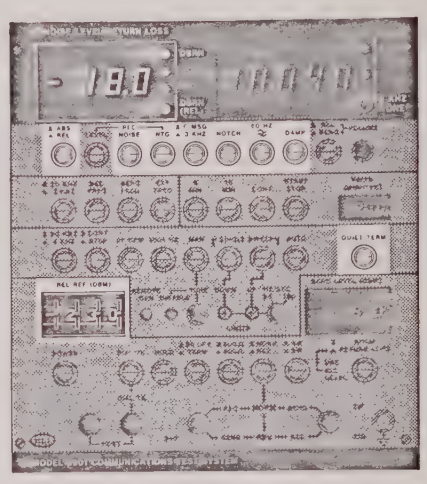

Figure 7. Noise Measurement Controls and Displays

A. Absolute Noise Measurement

6.04 To perform an absolute noise measurement, proceed as follows:

1) Set ABS/REL switch to ABS.
2) Set REC-NOISE switch to in position.
3) Refer to Section 6.E. for filter selection.
4) Refer to Section 4 for line interface information.
5) Read the absolute noise level directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DBRN indicator to the right of the display.

B. Relative Noise Measurement

6.05 To perform a relative noise measurement, proceed as follows:

1) Set ABS/REL switch to REL.
2) Set REC-NOISE switch to in position.
3) Refer to Section 6.E. for filter selection.
4) Refer to Section 4 for line interface information.
5) Set REL REF (DBM) thumbwheel switches to the desired reference (e.g., TLP, Data Level, etc.) level from +9.9 to −39.9 dBm.
6) Read the relative noise level directly from the NOISE/LEVEL RETURN LOSS display. The proper unit of measurement is indicated by the DBRN (REL) indicator to the right of the display.

Note: 90 dBrn (Rel) is equivalent to 0 dB.

C. Absolute Noise-to-Ground Measurement

6.06 To perform an absolute noise-to-ground measurement, proceed as follows:

1) Set ABS/REL switch to ABS.
2) Set REC-NTG switch to in position.

3) Refer to Section 6.E. for filter selection.
4) Refer to Section 4 for line interface information.
5) Read the absolute noise-to-ground level directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DBRN indicator to the right of the display. The level is referenced to 600 Ω in noise-to-ground measurements.

Note: Do not add a correction factor to the reading, as this is done internally.

D. Relative Noise-to-Ground Measurement

6.07 To perform a relative noise-to-ground measurement, proceed as follows:

1) Set ABS/REL switch to REL.
2) Set REC-NTG switch to in position.
3) Refer to Section 6.E. for filter selection.
4) Refer to Section 4 for line interface information.
5) Set REL REF (DBM) thumbwheel switches to the desired reference (e.g., TLP, Data Level, etc.) level from +9.9 to −39.9 dBm.
6) Read the relative noise-to-ground level directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DBRN (REL) indicator to the right of the display.

Note: Do not add a correction factor to the reading, as this is done internally. 90 dBrn (Rel) is equivalent to 0 dB.

E. Noise Filter Selection

6.08 When performing a noise or noise-to-ground measurement, select one or more of the following filters, as required:

- C-Message or 3 kHz Flat
- Notch
- 60 Hz High Pass

6.09 In all noise or noise-to-ground measurement modes and in the absence of plug-in noise filter modules, either the C-Message or the 3 kHz filter will always be in the circuit depending on the setting of the C-MSG/3 KHZ switch. If C-Message weighting is desired, set C-MSG/3 KHZ switch to C-MSG; if 3 kHz flat filtering is desired, set C-MSG/3 KHZ switch to 3 KHZ.

6.10 The Basic Unit contains a notch filter that can be selected by setting the NOTCH switch to in position. The notch filter will attenuate all frequencies in the band from 995 - 1025 Hz by at least 50 dB.

6.11 To reduce the effects of power line interference, a 60 Hz high-pass filter can be selected by setting the 60 HZ≈ switch to the in position. The 60 Hz filter may be selected in all noise or noise-to-ground measurement modes.

F. Damping

6.12 If the reading fluctuates due to noise or low repetition rate of the signal, it can be damped by setting the DAMP switch to in position.

G. Overrange and Underrange Indications

6.13 If the received noise level exceeds the measurement capabilities of the Basic Unit, one of the following overrange or underrange indications will occur:

- If the level goes above +100 dBrn or +100 dBrn (Rel) for noise, or above +130 dBrn or +130 dBrn (Rel) for noise-to-ground, the display will blank with the exception of a positive sign, indicating an overrange condition.
- If the level goes below +10 dBrn or +10 dBrn (Rel) for noise, or below +40 dBrn or +40 dBrn (Rel) for noise-to-ground, the display will blank with the exception of a negative sign, indicating an underrange condition.

H. Holding Tone Indicator

6.14 For easy verification of the presence of a holding tone when making noise-with-tone measurements, the 1 KHZ TONE LED is provided. For more detailed discussion of this feature, refer to Section 12.

7. FREQUENCY MEASUREMENT

7.01 This section describes the operating procedures for the Model 3901 Basic Unit frequency counter when performing the following:

- Receive Frequency Measurement
- Send Frequency Measurement
- External Frequency Measurement

Frequencies from 40 Hz to 19.999 kHz can be measured in two switch-selectable ranges. The frequency counter contains automatic overrange and underrange indications which occur when the applied frequency is outside the measurement limits. Refer to Figure 8 while performing the following procedures.

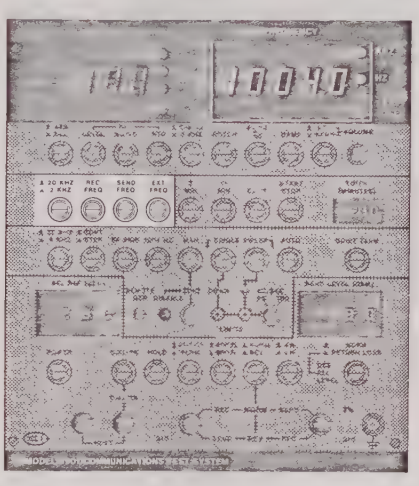

Figure 8. Frequency Measurement Controls and Displays

A. Receive Frequency Measurement

7.02 To perform a receive frequency measurement, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to desired frequency range.
2) Set REC FREQ switch to in position.
3) Refer to Section 4 for line interface information.
4) Read the receive frequency directly from the FREQUENCY display.

B. Send Frequency Measurement

7.03 To perform a send frequency measurement, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to desired frequency range.
2) Set SEND FREQ switch to in position.
3) Read send frequency directly from the FREQUENCY display.

Note: Send frequency can be measured in QUIET TERM mode, which permits frequency set up before going on-line.

C. External Frequency Measurement

7.04 To perform a measurement of an external frequency applied to the EXT-T, -R, -S five-way binding posts on the rear panel, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to desired frequency range.
2) Set EXT FREQ switch to in position.
3) Read external frequency directly from the FREQUENCY display.

7.05 The external input is extremely useful when performing third-point delay measurements. Refer to the DELAY Module Operating Manual (3912-M20) for detailed instructions.

D. Overrange and Underrange Indications

7.06 If the applied frequency exceeds the measurement capabilities of the Basic Unit, one of the following overrange or underrange indications will occur:

- If the frequency goes above 1999.9 Hz in the 2 kHz range, or above 19.999 kHz in the 20 kHz range, the FREQUENCY display will blank with the exception of a positive sign, indicating an overrange condition.
- If the frequency goes below 40 Hz in either the 2 kHz or 20 kHz range, the FREQUENCY display will blank with the exception of a negative sign, indicating an underrange condition.

8. SINE WAVE RETURN LOSS MEASUREMENT

8.01 This section describes the operating procedures for the Model 3901 Basic Unit when performing 2-wire and 4-wire return loss measurements. Return loss is indicated by positive (+) dB for 2-wire or 4-wire measurements. Refer to Figure 9 when performing the following procedures.

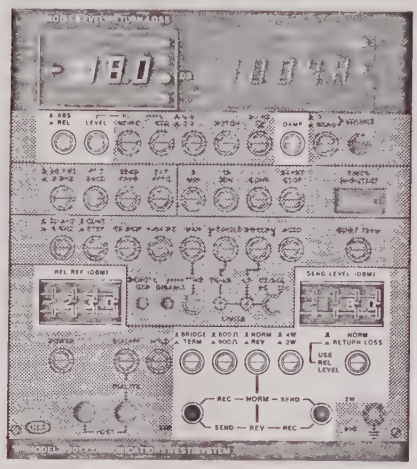

Figure 9. Sine Wave Return Loss Measurement Controls and Displays

A. 2-Wire Return Loss Measurement

8.02 To perform a 2-wire return loss measurement, proceed as follows:

1) Set ABS/REL switch to REL.
2) Set REC-LEVEL switch to in position.
3) Set DAMP switch to in position.
4) Set BRIDGE/TERM switch to TERM to use the internal standard impedance, or set the switch to BRIDGE and connect an external standard impedance to the NORM-REC jack.
5) Set 600 Ω/900 Ω switch to match line impedance if the internal standard impedance is being used. If external standard impedance is being used, omit this step.
6) Set NORM/REV switch to NORM.
7) Set 4W/2W switch to 2W.
8) Set NORM/RETURN LOSS switch to RETURN LOSS.
9) Refer to Section 10 for frequency set-up instructions.
10) Set SEND LEVEL (DBM) thumbwheel switches for the desired output level. ***Do not exceed 0.0 dBm.***
11) Set REL REF (DBM) thumbwheel switches to obtain a NOISE/LEVEL/RETURN LOSS display reading of 0.0 DB, with the line under test not connected.
12) Connect the line under test to the NORM-SEND jack and read the return loss directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DB indicator to the right of the display.

B. 4-Wire Return Loss Measurement

8.03 To perform a 4-wire return loss measurement, proceed as follows:

1) Set ABS/REL switch to REL.
2) Set REC-LEVEL switch to in position.
3) Set DAMP switch to in position.
4) Set BRIDGE/TERM switch to TERM.
5) Set 600 Ω/900 Ω switch to match line impedance.
6) Set NORM/REV switch to NORM.
7) Set 4W/2W switch to 4W.
8) Set NORM/RETURN LOSS switch to RETURN LOSS.
9) Connect the send and receive lines to the NORM-SEND, NORM-REC jacks, respectively.
10) Refer to Section 10 for frequency set-up instructions.
11) Set SEND LEVEL (DBM) thumbwheel switches for the desired output level. ***Do not exceed 0.0 dBm.***
12) With the 2-wire side of the hybrid opened, set REL REF (DBM) thumbwheel switches to obtain a NOISE/LEVEL/RETURN LOSS display reading of 0.0 DB.
13) Terminate 2-wire side of the hybrid and read the return loss directly from the NOISE/LEVEL/RETURN LOSS display. The proper unit of measurement is indicated by the DB indicator to the right of the display.

9. SEND LEVEL SETUP

9.01 This section describes the send level setup procedure for the Model 3901 Basic Unit. Refer to Figure 10 when performing the following setup procedure.

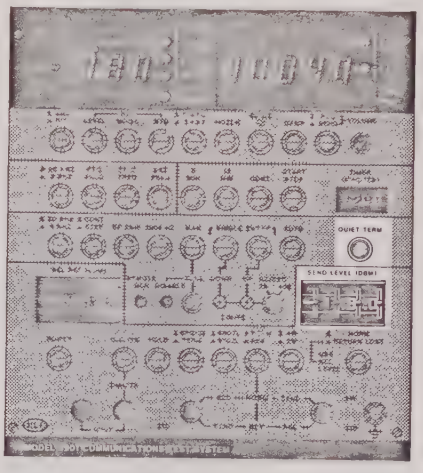

Figure 10. Send Level Setup Controls

A. Send Level Adjustment

9.02 Send level is adjustable in 0.1 dB steps from +9.9 to −39.9 dBm. It is set using the SEND LEVEL (DBM) thumbwheel switches which display proper send level to a matched termination.

B. Quiet Termination

9.03 When performing low-level measurements or noise-without-tone-measurements, it is recommended that the basic unit generator be turned off by setting the QUIET TERM switch to in position. (Quiet Termination mode overrides all other generator functions.)

10. SEND FREQUENCY SETUP

10.01 This section describes the send frequency setup procedures for the Model 3901 Basic Unit. The Basic Unit provides the following features and modes of operation:

- 40 - 4000 Hz or 200 - 20,000 Hz
- 100 Hz Lock with +4 Hz offset
- SF Skip
- Fixed 1004.0 Hz
- Manual Tune
- Single Sweep Down
- Single Sweep Up
- Automatic Sweep
- Quiet Termination

Refer to Figure 11 when performing the following send frequency setup procedures.

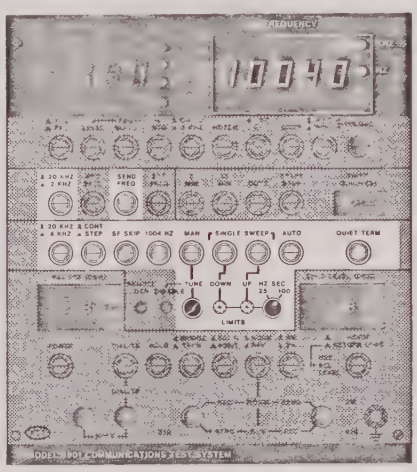

Figure 11. Send Frequency Setup Controls and Displays

A. Fixed 1004.0 Hz

10.02 To send 1004.0 Hz, set 1004 HZ switch to in position.

B. Manual Tune

10.03 To manually tune the basic unit generator, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to 20 KHZ.
2) Set SEND FREQ switch to in position.
3) Set 20 KHZ/4 KHZ switch to desired range.
4) Set CONT/STEP switch to desired mode.
5) Set SF SKIP switch to in position on circuits employing SF signaling.
6) Set MAN switch to in position.
7) Adjust MAN TUNE knob to desired frequency while observing the FREQUENCY display.

C. Single Sweep Up, Down

10.04 For single sweep operation, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to 20 KHZ.
2) Set SEND FREQ switch to in position.
3) Set 20 KHZ/4 KHZ switch to desired range.
4) Set CONT/STEP switch to desired mode.
5) Set SF SKIP switch to in position on circuits employing SF signaling.
6) Set HZ/SEC knob fully clockwise.
7) Set SINGLE SWEEP DOWN switch to in position.
8) Adjust DOWN LIMIT pot to desired lower frequency limit while reading the FREQUENCY display.
9) Set SINGLE SWEEP UP switch to in position.
10) Adjust UP LIMIT pot to desired upper frequency limit while reading the FREQUENCY display.
11) Set HZ/SEC knob to desired sweep rate. For single sweep operation, alternately set SINGLE SWEEP UP and SINGLE SWEEP DOWN switches to in position.

D. Automatic Sweep

10.05 For automatic sweep operation, proceed as follows:

1) Set 20 KHZ/2 KHZ switch to 20 KHZ.
2) Set SEND FREQ switch to in position.

3) Set 20 KHZ/4 KHZ switch to desired range.
4) Set CONT/STEP switch to desired mode.
5) Set SF SKIP switch to in position for circuits employing SF signaling.
6) Set HZ/SEC knob to fully clockwise position.
7) Set SINGLE SWEEP DOWN switch to in position.
8) Adjust DOWN LIMIT pot to desired lower frequency limit while reading the FREQUENCY display.
9) Set SINGLE SWEEP UP switch to in position.
10) Adjust UP LIMIT pot to desired upper frequency limit while reading the FREQUENCY display.
11) Set AUTO switch to in position.
12) Set HZ/SEC knob to desired sweep rate.

E. Quiet Termination

10.06 It is possible to set up send frequency in quiet termination mode, even though there is no signal being transmitted. This permits frequency setup prior to putting the signal on line.

11. TIMER OPERATION

11.01 This section describes use and operational features of the electronic timer on the Model 3901 Basic Unit. The timer is used for setting and measuring the time interval for totalizing measurements such as impulse noise counts. The timer also provides an interrupt indication to alert the operator that a change affecting the totalizing measurement has been made before the test period was finished. Refer to Figure 12 during following procedures.

11.02 Switches on the Basic Unit should be set for the desired measurement parameters before the measurement interval is started. As described in Paragraph 11.05, a timer interrupt indication may occur if these parameters are changed during a measurement. Module parameters should be set up prior to the initiation of the test so that no changes are necessary during the test.

Note: The timer cannot be activated unless an appropriate plug-in module is turned on.

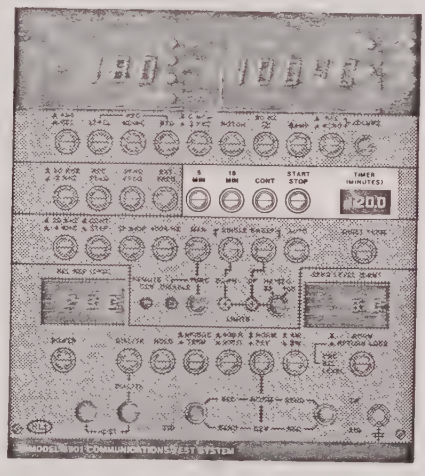

Figure 12. Timer Controls and Display

11.03 To start the timer, proceed as follows:

1) Select timer interval by setting desired switch (5 MIN, 15 MIN, CONT) to in position.
2) Set the basic unit switches for the desired measurement parameters.
3) Set up parameters on plug-in module(s) to be used. Refer to the operating manual for the appropriate module(s).
4) Turn on the desired plug-in module(s).
5) To start the timer, momentarily press START/STOP switch.
6) To stop the timer, press START/STOP switch again.

11.04 If the timer interval is set to either 5 MIN or 15 MIN, the timer will automatically time out after the desired interval has elapsed. In CONT mode, the timer will count past 999.9 minutes if not stopped by activating START/STOP switch.

A. Interrupt Indication

11.05 The basic unit TIMER (MINUTES) display will flash at a 1 Hz rate to alert the operator that the totalizing measurement has been interrupted because a change in measurement parameters has occurred.

11.06 A timer interrupt indication will occur if any of the following switch settings are changed during an impulse noise measurement.

- ABS/REL
- NTG
- C-MSG/3 KHZ
- NOTCH
- 60 HZ
- 5 MIN
- 15 MIN
- CONT
- START/STOP

11.07 A timer interrupt indication will occur if any of the following switch settings are changed during a hits and jitter measurement.

- NTG
- 5 MIN
- 15 MIN
- CONT
- START/STOP

11.08 Activation of other plug-in modules while any totalizing measurement is in progress may also cause a timer interrupt indication to occur.

11.09 Changes to the Basic Unit relative reference level settings or changes to the switch settings on plug-in module(s) during a measurement will not interrupt operation of the timer.

12. INDICATORS

12.01 This section describes the function of the Model 3901 Basic Unit LED indicators, and the operating conditions which will cause them to turn on and off. Shown in Figure 13 are three LED indicators other than the ones already discussed in various measurement modes.

- 1 KHZ TONE
- TUNE DISABLE
- REMOTE GEN

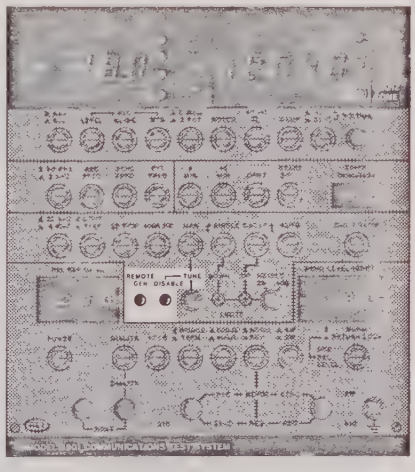

Figure 13. Basic Unit LED Indicators

A. 1 kHz Tone

12.02 The 1 KHZ TONE indicator is a green LED in the corner of the FREQUENCY display window. The LED will be on only when both of the following conditions are satisfied:

- Receive frequency is between 990 and 1030 Hz
- Receive level is between +10 and −40 dBm

The 1 KHZ TONE indicator will flash on and off if the receive level is within the specified limits, and the receive frequency is within one of the following bands:

- 980 to 990 Hz
- 1030 to 1040 Hz

The 1 KHZ TONE indicator will be off if any of the following conditions exist:

- Receive frequency is below 980 Hz
- Receive frequency is above 1040 Hz
- Receive level is above +10 dBm
- Receive level is below −40 dBm

B. Tune Disable

12.03 The TUNE DISABLE indicator will be on whenever the basic unit signal generator is being remotely tuned. When the indicator is on, the following generator switches and controls have no effect on the output signal:

- MAN
- SINGLE SWEEP DOWN, UP
- AUTO
- MAN TUNE
- UP, DOWN LIMIT
- HZ/SEC

The Basic Unit will however, maintain control of the following switches, even when the TUNE DISABLE indicator is on:

- 20 KHZ/4 KHZ
- CONT/STEP
- SF SKIP
- 1004 HZ
- QUIET TERM

C. Remote Generator

12.04 The REMOTE GEN indicator will be on whenever a plug-in module containing its own generator is activated. When the indicator is on, the basic unit generator is not providing an output signal. Therefore, the following basic unit generator switches and controls have no effect on the output signal:

- 20 KHZ/4 KHZ
- CONT/STEP
- SF SKIP
- 1004 HZ
- MAN TUNE
- AUTO
- SINGLE SWEEP DOWN, UP

13. AUDIO MONITOR

13.01 This section describes the operation of the Model 3901 Basic Unit audio monitor.

13.02 The Basic Unit is equipped with a built-in speaker (on the rear panel) and a REC/SEND switch which allows the operator to listen to either the receive or the send signal. Adjust the VOLUME control knob for comfortable listening level. Figure 14 shows the REC/SEND switch and VOLUME control knob.

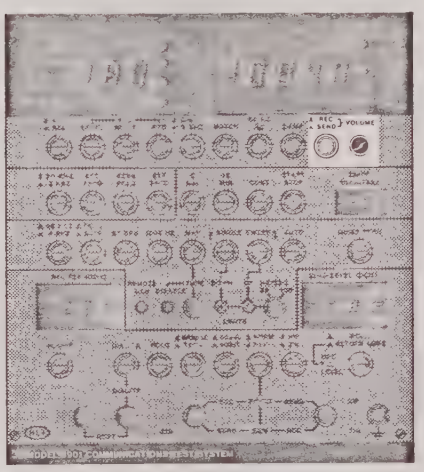

Figure 14. Audio Monitor Control

14. REAR PANEL FACILITIES

14.01 This section describes the facilities located on the rear panel. Rear panel connectors, as shown in Figure 15, provide convenience outputs and facilitate operation when the Basic Unit is rack mounted. The following input and output signals are available:

- Frequency output (dc voltage proportional to frequency)
- DB Level output (dc voltage proportional to level)
- Delay output (dc voltage proportional to delay)*
- Demodulated Phase Jitter Waveform*
- Demodulated Amplitude Jitter Waveform*
- Monitor output
- Receive and Send (parallel to front panel receive and send jacks) five-way binding post connections.

*Contingent upon presence of appropriate modules.

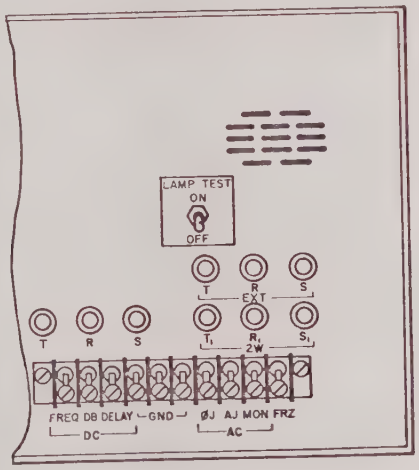

Figure 15. Rear Panel Facilities

Lamp Test and Display Freeze are two more functions provided on the rear panel. Input connectors for measuring an external frequency (useful in third-point delay measurements) are also provided.

A. Lamp Test

14.02 The LAMP TEST switch provides the means to verify operation of all digital displays and indicators on the Model 3901 Basic Unit and plug-in modules that are on. Setting the LAMP TEST switch to ON turns on all segments of each LED readout and indicator on the Basic Unit and the enabled modules.

B. Display Freeze

14.03 Display readings on the Basic Unit and any enabled plug-in module(s) can be frozen for ease of observation by applying chassis ground through a dry contact closure to the barrier-strip terminal marked FRZ.

> **WARNING:** To avoid damaging the unit due to large off-ground (foreign) voltages, the ground used for the Freeze must be from one of the GND terminals provided on the rear panel barrier strip.

14.04 When the Basic Unit is placed in the Freeze mode, the displayed information is not affected by changes in the input signal. However, if any Basic Unit or plug-in module control settings are changed, the displayed information may also change.

C. Inputs

14.05 The five-way binding posts identified as 2W-T_1, R_1 and S_1 are connected in parallel with the basic unit NORM-SEND front panel jack, and the five-way binding posts identified as T, R and S are connected in parallel with the NORM-REC front panel jack. These rear panel connectors may be used in an identical manner to the front panel jacks as described in Section 4, LINE INTERFACES.

14.06 There are also five-way binding post input connectors, identified as EXT-T, -R and -S, that may be used for counting fre-

quency. This input, with a bridging impedance in excess of 10 kΩ for frequency higher than 1 kHz, provides a frequency measurement capability in excess of 4 kHz with signal levels as low as −40 dBm. It may be used, as a convenience, to measure the frequency of any signal within the specified limits and to perform third-point delay measurement.

D. DC Outputs

14.07 The following dc outputs are provided with a source impedance of 2 kΩ and are available on the rear panel barrier strip terminals:

- DC - FREQ
- DC - DB
- DC - DELAY

14.08 The FREQ is an analog output whose voltage varies proportionally with the frequency being measured. The scale factor is 2 V/kHz when the Basic Unit generator is set to 4 kHz range, and 0.4V/kHz in 20 kHz range.

14.09 The DB is an analog output whose voltage varies proportionally with the level of the signal being measured. The scale factor is 1 V/10 dB with zero volts corresponding to the following table:

	ABS	REL
LEVEL	0 dBm	0 dB
NOISE	+90 dBrn	+90 dBrn (REL)
NOISE-TO-GROUND	+120 dBrn	+120 dBrn (REL)

14.10 The DELAY is an analog output whose voltage varies proportionally with the delay being measured. The scale factor is 0.5 V/1000 μsec with zero volts corresponding to zero microseconds. This output is only available when the appropriate plug-in module is installed.

E. AC Outputs

14.11 The following ac outputs are provided with a source impedance of 2 kΩ and are available on the rear panel barrier strip terminals:

- AC - ØJ
- AC - AJ
- AC - MON

14.12 The ØJ output is demodulated phase jitter waveform whose scale factor is 1 V/10° peak-to-peak jitter. This output is only available when the appropriate plug-in module is installed.

14.13 The AJ output is demodulated amplitude jitter waveform whose scale factor is 1 V/10% peak jitter. This output is only available when the appropriate plug-in module is installed.

14.14 The MON output carries the same audio signal used to drive the monitor speaker, but the VOLUME knob has no effect on this output.

15. SELF-TEST

15.01 This section describes the procedures for self-testing the Model 3901 Basic Unit. These procedures are to be used for self-test purposes only, and are not intended for calibration. (Calibration is covered in Service Manual, 3901-M30.) A looping cord and two jumper wires are required to do self-check. Perform the following self-check procedures in sequence.

A. Initial Switch Settings

WARNING: Check to see that the 115/230 volt selector switch, located on the rear panel, is set to the correct position.

Proceed as follows:

1) Connect the ac power cord to the rear panel receptacle and power source.
2) Connect looping cord from the NORM-REC jack to the NORM-SEND jack.
3) Set REC-LEVEL switch to in position.
4) Set REC FREQ switch to in position.
5) Set 5 MIN switch to in position.
6) Set 1004 HZ switch to in position.
7) Adjust REL REF (DBM) thumbwheel switches for +00.0.
8) Adjust SEND LEVEL (DBM) thumbwheel switches for +00.0.
9) Set BRIDGE/TERM switch to TERM.
10) Set all remaining switches to out position.
11) Set POWER switch to in position.
12) Adjust VOLUME control for a comfortable level.

B. Level/Noise Check

15.02 To perform the level/noise checks, proceed as follows:

1) Observe that the NOISE/LEVEL/RETURN LOSS display reads 0.0 ±0.2 DBM.
2) Observe that 1 KHZ TONE LED is on.
3) Set ABS/REL switch to REL.
4) Observe that the NOISE/LEVEL/RETURN LOSS display reads 0.0 ±0.2 DB.
5) Set REC-NOISE switch to in position.
6) Observe that the NOISE/LEVEL/RETURN LOSS display reads +90 ±1 DBRN (REL).
7) Set ABS/REL switch to ABS.
8) Observe that the NOISE/LEVEL/RETURN LOSS display reads +90 ±1 DBRN.
9) Set REC-NTG switch to in position.
10) Connect the five-way binding posts labeled T and S on the rear panel with a jumper wire.
11) Observe that the NOISE/LEVEL/RETURN LOSS display reads +84 ±2 DBRN.
12) Remove the jumper wire installed in step 10.
13) Set REC-LEVEL switch to in position.
14) Set QUIET TERM switch to in position.
15) Observe that the NOISE/LEVEL/RETURN LOSS display blanks with the exception of the negative sign.
16) Set QUIET TERM switch to out position.
17) Set BRIDGE/TERM switch to BRIDGE.
18) Observe that the NOISE/LEVEL/RETURN LOSS display reads 6.0 ±0.2 DBM.
19) Adjust SEND LEVEL (DBM) thumbwheel switches for +05.0.
20) Observe that the NOISE/LEVEL/RETURN LOSS display blanks with the exception of the positive sign.

C. Frequency Counter Check

15.03 To perform the frequency counter check, proceed as follows:

1) Set BRIDGE/TERM switch to TERM.
2) Observe that the FREQUENCY display reads 1.004 ±0.001 KHZ.
3) Set QUIET TERM switch to in position.
4) Observe that the FREQUENCY display blanks with the exception of negative sign.
5) Set SEND FREQ switch to in position.
6) Observe that the FREQUENCY dis-

play reads 1.004 ±0.001 KHZ.
7) Set 20 KHZ/2 KHZ switch to 2 KHZ.
8) Observe that the FREQUENCY display reads 1004.0 ±0.1 HZ.
9) Connect the five-way binding posts laveled T and EXT-T with a jumper wire, and R and EXT-R with a jumper wire.
10) Set EXT FREQ switch to in position.
11) Observe that the FREQUENCY display blanks with the exception of the negative sign.
12) Set QUIET TERM switch to out position.
13) Observe that the FREQUENCY display reads 1004.0 ±0.1 HZ.
14) Remove the jumper wires installed in step 9.

D. Generator Check

15.04 To perform the generator check, proceed as follows:
1) Set 20 KHZ/2 KHZ switch to 20 KHZ.
2) Set SEND FREQ switch to in position.
3) Set MAN switch to in position.
4) Turn MAN TUNE knob fully clockwise.
5) Observe that the FREQUENCY display blanks with the exception of the positive sign.
6) Set 20 KHZ/4 KHZ switch to 4 KHZ.
7) Observe that the FREQUENCY displayed exceeds 4.000 KHZ.
8) Set CONT/STEP switch to STEP.
9) Slowly turn the MAN TUNE control fully counterclockwise.
10) Observe that the FREQUENCY changes in 100 Hz steps with a +4 ±1 Hz offset.
11) Set CONT/STEP switch to CONT.
12) Observe that the FREQUENCY display blanks with the exception of the negative sign.
13) Turn the HZ/SEC knob fully clockwise.
14) Set SINGLE SWEEP UP switch to in position.
15) While varying the UP LIMIT control setting, verify that the FREQUENCY display indication increases when the control is turned clockwise, and decreases when the control knob is turned counterclockwise.
16) Adjust the UP LIMIT control to obtain a FREQUENCY display of 4.000+0.020 KHZ.
17) Set SINGLE SWEEP DOWN switch to in position.
18) While varying the DOWN LIMIT control setting, verify that the FREQUENCY display indication increases when the control is turned clockwise, and decreases when the control is turned counterclockwise.
19) Adjust the DOWN LIMIT control to obtain a FREQUENCY display of 2.000 ± 0.020 KHZ.
20) Set AUTO switch to in position.
21) Observe that the FREQUENCY sweeps between the two limits.
22) While varying the HZ/SEC control, observe that the sweep rate decreases when the control is turned counterclockwise and increases when the control is turned clockwise.

Note: In AUTO SWEEP mode, if the UP LIMIT is set lower than the DOWN LIMIT, the generator will stay at the down limit setting.

23) Set QUIET TERM switch to in position and observe that NOISE/LEVEL/RETURN LOSS display blanks with the exception of negative sign.
24) Set QUIET TERM switch to out position.
25) Set MAN switch to in position.
26) Set SF SKIP switch to in position.
27) While slowly varying the MAN TUNE knob, observe that the Basic Unit generator skips and/or mutes (depending on the option selected) the frequency band from 2450 to 2750 Hz.

E. Filter Response Check

15.05 To perform the filter response check, proceed as follows:

1) Set REC-NOISE switch to in position.
2) Set SEND LEVEL (DBM) thumbwheel switches to +00.0.
3) Vary the MAN TUNE knob to verify that the NOISE/LEVEL/RETURN LOSS display indication follows the C-Message filter response specifications per Bell PUB 41009.
4) Set C-MSG/3 KHZ switch to 3 KHZ.
5) Vary the MAN TUNE control to verify that the NOISE/LEVEL/RETURN LOSS display indication follows the 3 kHz filter response specification.
6) Set NOTCH switch to in position.
7) Vary the MAN TUNE control to verify that the NOISE/LEVEL/RETURN LOSS display follows the notch response specification.
8) Set 60 HZ ≈ switch to in position.
9) Vary the MAN TUNE control to verify that the NOISE/LEVEL/RETURN LOSS display follows the 60 Hz filter response specification.

F. Timer Check

15.06 For timer self-test check, refer to the applicable totalizing measurement plug-in module operating manual. This completes the self-test.

16. BOARD INSTALLATION/ REMOVAL

16.01 This section describes the procedures for installation/removal of individual boards in the Model 3901 Basic Unit. Only the boards and assemblies described below are normally field serviced.

A. Front Panel and Boards

16.02 As shown in Figure 16, the Basic Unit contains the following boards:

- Display
- Range
- Timer
- Generator
- I/O

DANGER: Hazardous voltages exist inside this instrument. Disconnect power cord from unit before proceeding.

16.03 To remove and install individual boards in the Basic Unit, proceed as follows:

1) Remove the mounting screws from the front panel of the Basic Unit and remove the front panel.
2) Remove the Display, Range and Timer boards by inserting the card extractor (stored on rear panel) into the board and pulling forward.

WARNING: To avoid damaging the Generator and I/O boards, they must be removed together.

3) Place the card extractor into the Generator board and pull forward approximately 1/4 inch.
4) Place the card extractor into the I/O board and pull forward approximately 1/4 inch.
5) Grasp both the Generator and the I/O cards, and pull forward until they both clear the Basic Unit.
6) To install the boards, reverse the removal procedure, and gently slide them into the Basic Unit together until they are firmly seated in the edge connector.
7) Replace the basic unit front panel.

16.04 For repair or servicing by HLI, refer to Section 17.

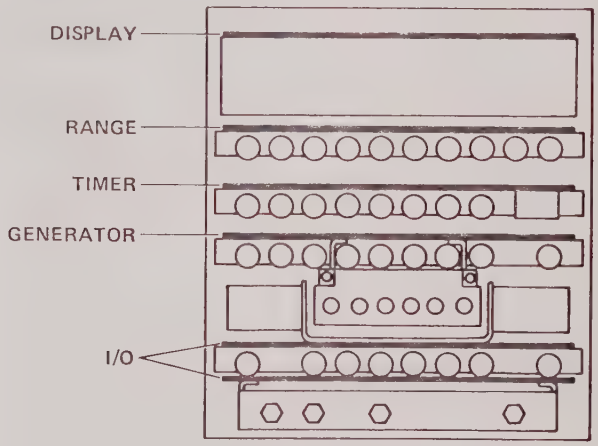

Figure 16. Basic Unit PC Board Identification

B. Rear Panel and Power Supply Board

16.05 The rear panel may be replaced as a complete assembly or, alternately, only the power supply board may be replaced.

WARNING: Disconnect power cord from unit before proceeding.

16.06 To remove and reinstall the rear panel on the Basic Unit, proceed as follows:

1) Remove the six screws on the rear of the enclosure's left and right sides (three screws per side) that hold the rear panel to the enclosure.
2) Remove the two screws on the rear bottom of the enclosure that hold the rear panel to the enclosure.
3) Carefully pull the rear panel out of the enclosure and detach the two cables which connect the rear panel to the Basic Unit. The rear panel may now be repaired or replaced.
4) Replace the rear panel using the reverse procedure.

16.07 To remove and reinstall the power supply board, first remove the rear panel as described in paragraph 16.06 and proceed as follows:

1) Remove the four screws at each corner of the power supply board and disengage it from the PC edge connector.
2) Replace the power supply board using the reverse procedure.

16.08 For repair or servicing by HLI, refer to Section 17.

17. PACKING AND SHIPPING, AND RETURN TO FACTORY

17.01 This section contains procedures to be followed when returning the Model 3901 Basic Unit (or individual boards) to the factory for repair or servicing. Note that most problems with the Basic Unit can be isolated to the individual board level because of functional organization; it is recommended, therefore, that the factory be consulted by telephone or letter before shipping the unit.

A. Complete Unit

17.02 The original packing materials and shipping container for the Basic Unit should be stored for use when shipment (between customer locations or return to factory) becomes necessary.

17.03 If the unit is being returned to HLI for repair or servicing, enclose the following information:

- Type of repair or service required
- Model number and serial number
- Return address

Keep a copy of all information for yourself and refer to your copy in any correspondence with the factory.

17.04 If original packing materials and shipping container are unavailable, repack the unit as follows:

1) If shipping Basic Unit and plug-in modules together, check that the modules are correctly installed.
2) Wrap the unit in heavy paper or plastic. Tape loose edges.
3) Surround the wrapped unit in 5 to 10 cm (2 to 4 inches) thick shock-absorbing material.
4) Place the package in a strong, double-walled shipping container. Fill excess spaces with newspapers.
5) Seal the container securely.
6) Mark the container:
   FRAGILE – DELICATE
   ELECTRONIC INSTRUMENT

B. Basic Unit Boards

17.05 To remove boards from Basic Unit, refer to Section 16.A. To pack and ship a board, refer to Section 17.D.

C. Rear Panel and Power Supply Board

17.06 To remove the rear panel and/or the power supply board, refer to Section 16.B. To pack and ship the rear panel with or without the power supply board, handle it as a unit, following instructions in Section 17.A. To pack and ship the power supply board alone, refer to Section 17.D.

D. Individual Boards

17.07 When a board has been extracted from the Basic Unit, handle the board by the top and bottom edges of the board only. DO NOT handle the rear edge connector. Static electricity may damage the CMOS IC's on the board(s).

17.08 If the board is being returned to HLI for servicing or repair, enclose the following information:

1) Type of service or repair required
2) Model and serial number of the Basic Unit from which the board was extracted
3) Serial number of the board
4) Return address

Retain a copy of all information for yourself and refer to your copy in any correspondence with HLI.

17.09 Boards shipped separately from the factory are enclosed in a special conductive envelope that protects the circuitry from static electricity. This protective envelope should be retained and used for reshipment. If the conductive envelope is not available, DO NOT wrap the board in an ordinary plastic bag or plastic sheeting. Instead, proceed as follows:

1) If available, cover the entire rear edge connector with a conductive shorting bar.

2) Wrap the board in heavy kraft paper.
3) Surround the wrapped board in 5 to 10 cm. (2 to 4 inches) thick shock-absorbing material.
4) Place the package in a strong, double-walled shipping container. Fill excess spaces with newspapers.
5) Seal the container securely.
6) Mark the container: FRAGILE – DELICATE ELECTRONIC INSTRUMENT.